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(56) Documents cited
GB 1354669 A GB 0890522 A GB 0532667 A
GB 0412050 A GB 0246644 A

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(54) Variable ratio drive system comprising spur gears mounted on freewheel clutches driven by eccentric levers

(57) A fixed frame has four gears (1–4) each meshing up one to the other and each containing a freewheel clutch (20–24) to which it is rigidly attached. A circular shaft is fixed to the inner member of each freewheel clutch or alternatively may comprise the inner member of each of these clutches. To each of these shafts (or inner members) is attached a lever (9–12) which may be linked to a variable throw crankshaft.

The eccentricity of a variable throw centre section (17) is adjusted by means of rotation of a lever attached to the centre section (17) which has a circumferential groove housing sliding blocks.

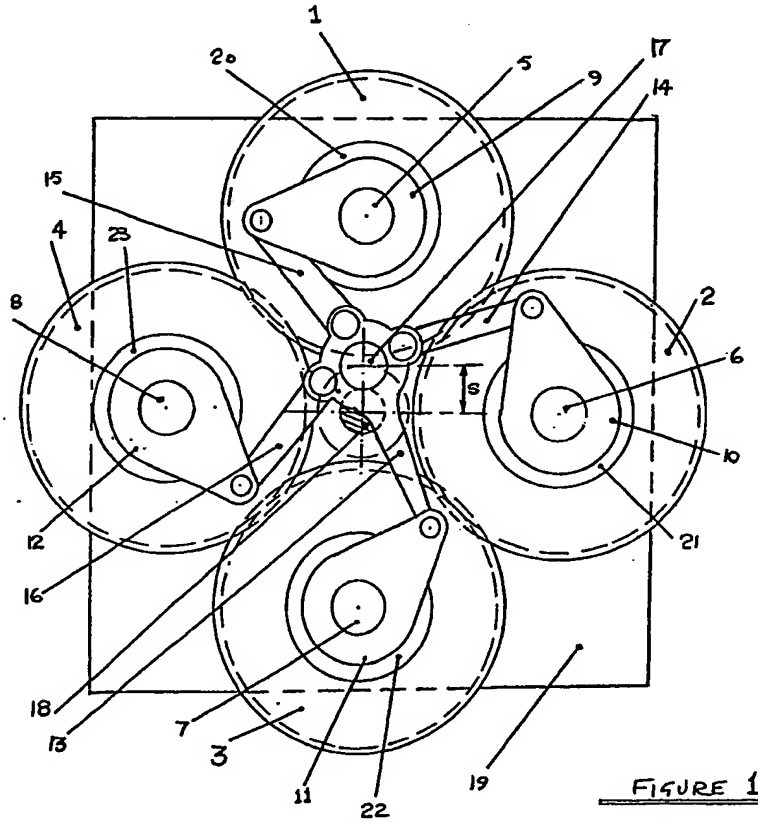


FIGURE 1

GB 2 259 741 A

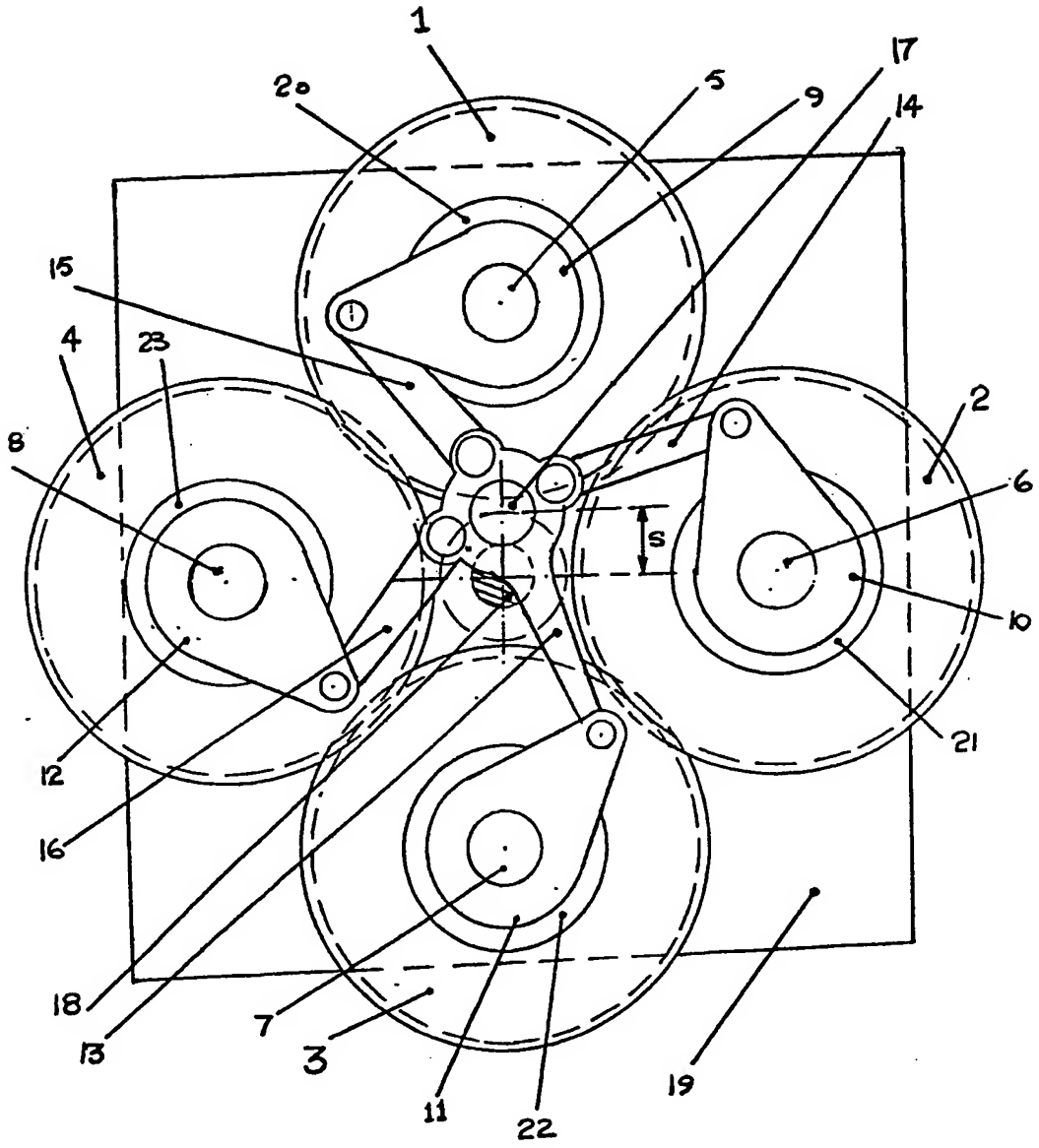


FIGURE 1

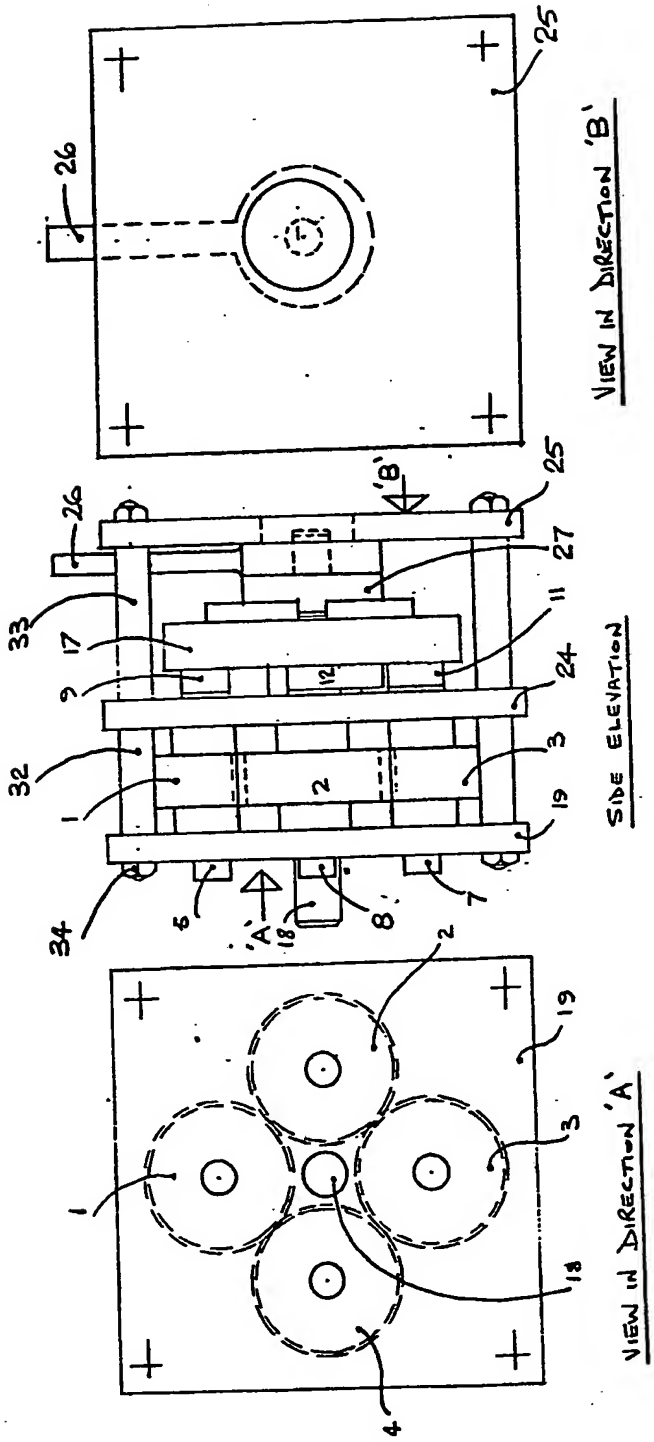
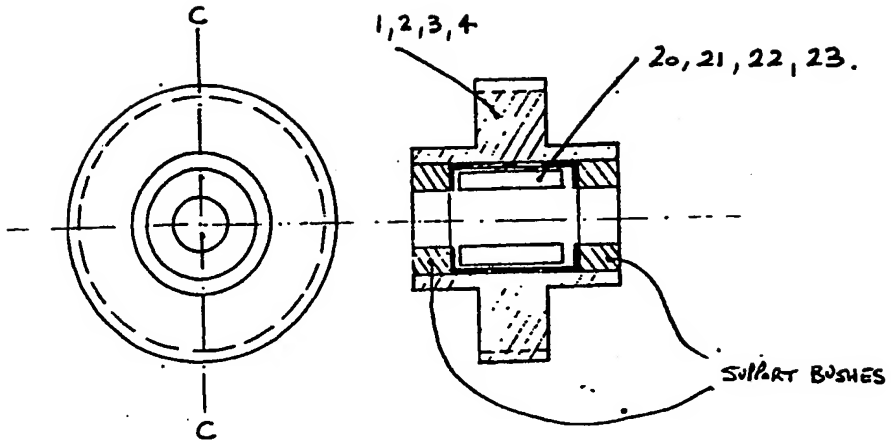
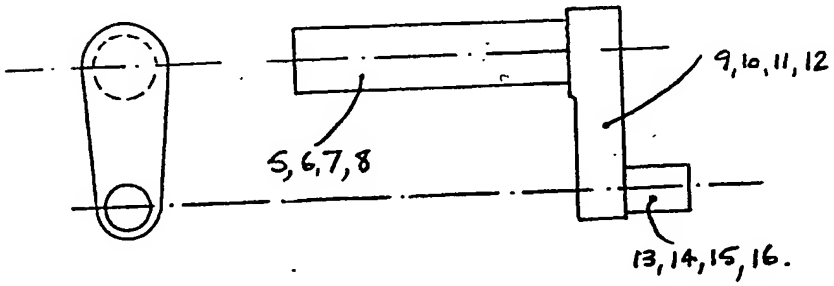

25
26
VIEW IN DIRECTION 'B'
'B'
25
26
27
33
17
11
12
24
32
3
2
1
19
34
5
'A'
18
8
7
2
19
3
1
18
4
VIEW IN DIRECTION 'A'
SIDE ELEVATION

FIGURE 2



SPUR GEARS 1,2,3,4 – DETAIL SECTION C-C

CONTAINING FREEWHEEL CLUTCHES 20,21,22,23
RESPECTIVELY AND SUPPORT BUSHES AS NECESSARY



SHAFTS 5,6,7,8 AND LEVERS 9,10,11,12
RESPECTIVELY AND PINS 13,14,15,16. RESPECTIVELY

FIGURE 3

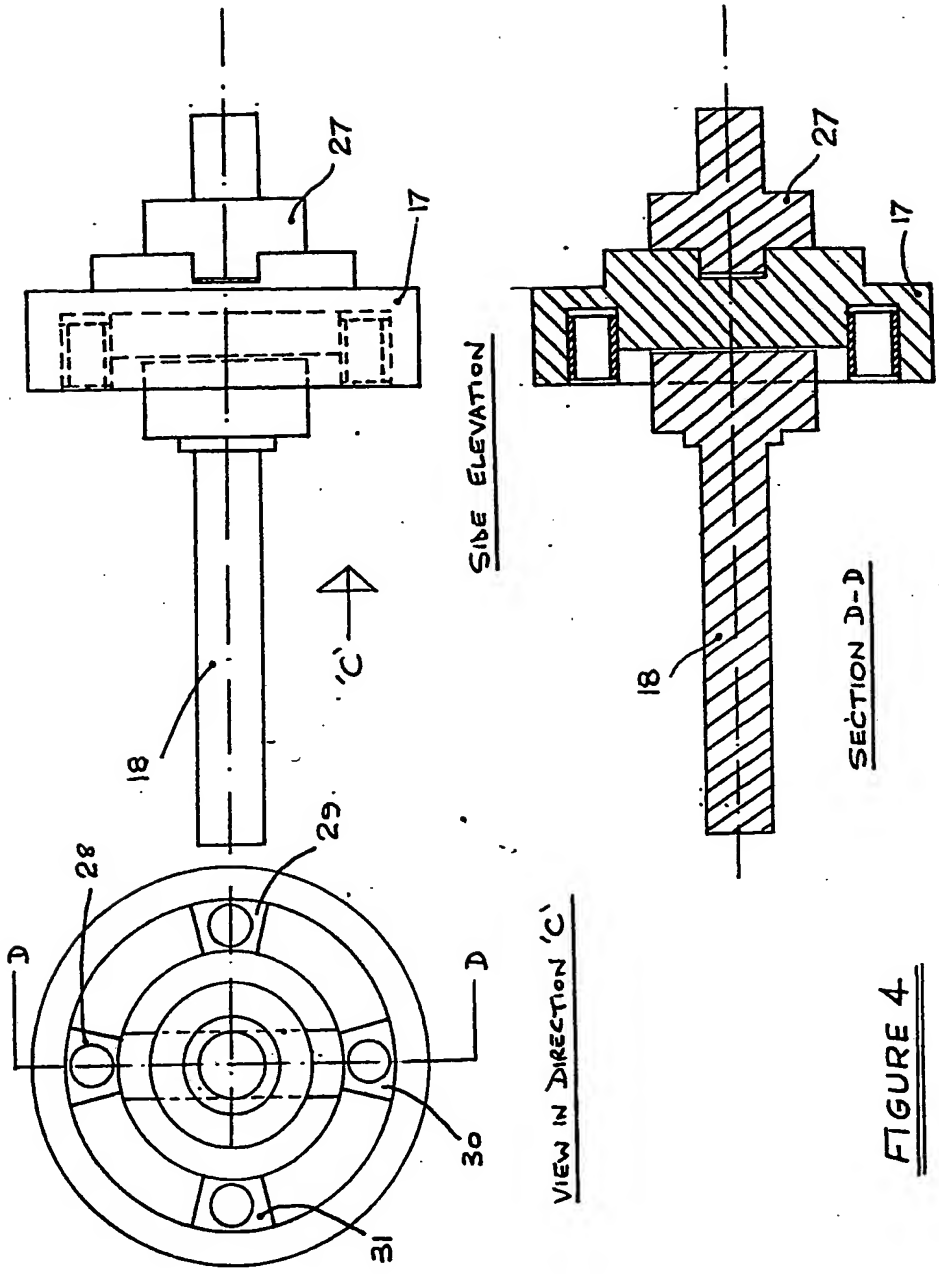

27
17
18
'C'
SIDE ELEVATION
27
17
18
SECTION D-D
29
28
D
D
30
31
VIEW IN DIRECTION 'C'

FIGURE 4

MECHANICAL VARIABLE RATIO DRIVE SYSTEM

This invention relates to a mechanical variable drive system that may be configured to control its output speed smoothly over any range between zero and any prescribed maximum.

Mechanical variable speed drives are well known and have been used with limited success in low power applications but are often complex and do not usually provide a smooth output angular velocity or torque at a given input speed. This is particularly true when the output speed is low with a correspondingly low output load inertia. As a consequence of the above it has often been necessary to use hydraulic transmission systems which are complex and expensive.

According to the present invention there is provided a mechanical variable ratio drive system comprising a fixed frame, four spur gears all of which mesh one to the other and are carried in the frame, four freewheel clutches the outer members of which are rigidly attached to each gear, four circular shafts rigidly attached to or comprising the inner member of each freewheel clutch, four levers each of which is attached to each of the aforementioned shafts, a variable stroke crank shaft or similar and four connecting rods or similar joining each of the levers to the crank.

The rotary input to the crank shaft is the drive system input and any of the four gears are the drive system output. A preferable method of varying the stroke of the crank will be shown but other well known methods may be utilised.

The principles of the invention are shown in Figure 1 which is for illustrative purposes only.

Figure 1 shows four spur gears 1, 2, 3 and 4 meshing one to the other each containing freewheel clutches 20, 21, 22 and 23 respectively. Freewheel clutches 20 and 22 engage for the same rotational direction of shafts 5 and 6 and freewheel clutches 21 and 23 engage in opposite sense to freewheel clutches 20 and 22, ie freewheel clutches that are opposite one another in diagram Figure 1 have the same sense of engagement but freewheel clutches that are adjacent in Figure 1 have opposite senses of engagement. Rigidly attached to shafts 5, 6, 7 and 8 are levers 9, 10, 11 and 12 respectively. Lever 11 is shown connected at its far end to a master connecting rod 13 from which is articulated connecting rods 15, 14 and 16 whose other ends are connected to levers 9, 10 and 12 respectively.

The other end of master connecting rod 13 is connected to crank pin 17 which is made to orbit by means of input shaft 18. The distance indicted by "S" in Figure 1 may be made variable such that levers 9, 10, 11 and 12 may have their amount of vibration varied.

Input shaft 18 and shafts 5, 6, 7 and 8 are rotatably held in frame 19.

It can clearly be seen, by reference to Figure 1, that if input shaft 18 is rotated when "S" is set to zero, then levers 9, 10, 11 and 12 will not vibrate and gears 1, 2, 3 and 4 will not rotate.

However if distance "S" is made finite then levers 9, 10, 11 and 12 will vibrate when shaft 18 is rotated and via freewheel clutches 20, 21, 22 and 23 will impart rotary motion to gears 1, 2, 3 and 4.

The angular rate of this motion will be proportional to the speed of input shaft 18 multiplied by distance "S". The sense of rotation of input shaft 18 does not determine the sense of rotation of gears 1, 2, 3 and 4. Gears 1, 2, 3 and 4 rotate in a direction determined by the sense of engagement of freewheel clutches 20, 21, 22 and 23 only.

A specific practical embodiment of the invention will now be described by way of example with reference to the following drawings :

Figure 2 - General Arrangement

Figure 3 - Details of Spur Gears

Figure 3 - Details of Shafts, Levers and Pins

Figure 4 - Detail of Variable Stroke Assembly

Individual components are identified in these figures by reference numbers as follows :

Reference Number	Component
1	Spur Gear
2	Spur Gear
3	Spur Gear
4	Spur Gear
5	Shaft
6	Shaft
7	Shaft
8	Shaft
9	Lever
10	Lever
11	Lever
12	Lever
13	Pin
14	Pin
15	Pin

16	Pin
17	Variable Throw Centre Section
18	Input Shaft
19	Front Frame
20	Freewheel Clutch
21	Freewheel Clutch
22	Freewheel Clutch
23	Freewheel Clutch
24	Centre Frame
25	End Frame
26	Eccentric Bearing and Lever
27	Driven Coupling Member
28	Sliding Block
29	Sliding Block
30	Sliding Block
31	Sliding Block
32	Frame Support Pillar)
33	Frame Support Pillar)4 places
34	Clamp Nut - 8 places

The components shown in Figures 2, 3 and 4 are not to scale and are shown in order to illustrate how an example of the invention may be configured to achieve the system requirements.

Figure 2 shows four Spur Gears 1, 2, 3 and 4 meshing one to the other retained between Front Frame 19 and Centre Frame 24. Each of Spur Gears 1, 2, 3 and 4

have retained within them Freewheel Clutches 20, 21, 22 and 23 respectively as shown in Figure 3.

Passing through Front Frame 19, Freehweel Clutches 20, 21, 22 and 23 and Centre Frame 24 are Shafts 5, 6, 7 and 8 respectively to which Levers 9, 10, 11, 12 and Pins 13, 14, 15 and 16 respectively are rigidly attached.

The Freewheel Clutches 20, 21, 22 and 23 are arranged such that 20 and 22 engage for the same sense of rotation of Shafts 5 and 7 and 21 and 23 engage with Shafts 6 and 8 for the opposite sense of rotation, ie the Freewheel Clutches are configured such that adjacent Spur Gears contain Freewheel Clutches with an opposite sense of engagement.

Also passing through Centre Frame 24 and Front Frame 19 is Input Shaft 18 which engages by means of a tongue a slot in Variable Throw Centre Section 17. On the other side of Variable Throw Centre Section 17 is another slot which is at 90 degrees to that with which Input Shaft 18 engages. This slot engages with a tongue on Driven Coupling Member 27 which runs freely within a bearing attached to Eccentric Bearing and Lever 26.

The Eccentric Bearing and Lever 26 is rotatably retained in End Frame 25 such that the Central Axis of Input Shaft 18 and Driven Coupling Member 27 may be varied between zero and some design maximum. When the Central Axis of 18 and 27 are axially in line the Variable Throw Centre Section 17 is arranged to have zero eccentricity.

In Variable Throw Centre Section 17 is formed a concentric groove which contains Sliding Blocks 28, 29, 30 and 31 each of which has formed in it a hole in which Pins 13, 14, 15 and 16 may rotatably engage. Thus when Input Shaft 18 is rotated Levers 9, 10, 11 and 12 will oscillate an amount determined by the offset of the Driven Coupling Member 27. When this offset is zero the amount of oscillation of Levers 9, 10, 11 and 12 will be zero and Spur Gears 1, 2, 3 and 4 will not rotate. When the offset of Driven Coupling Member 27 is finite then Spur Gears 1, 2, 3 and 4 will rotate at a speed determined by this offset and the rotational speed of Input Shaft 18.

The speed of Spur Gears 1, 2, 3 and 4 may therefore be adjusted by means of the Lever on Eccentric Bearing 26.

The output of this Mechanical Variable Ratio Drive System may be taken from either of Spur Gears 1, 2, 3 and 4 in any convenient way.

The complete assembly is shown in Figure 2 assembled by means of Frame Support Pillars 32 and 33 and Clamp Nuts 34 but any convenient arrangement may be employed.

CLAIMS

1 A mechanical variable ratio drive system whereby the velocity ratio between the output speed and the input speed may be varied continuously at will, between zero and a design maximum.

2 A mechanical variable ratio drive system as claimed in Claim 1 wherein the oscillation of a set of levers may be controlled between zero and a design maximum by means of a groove which varies its eccentricity dependent on the position of a lever.

3 A mechanical variable ratio drive system as claimed in Claim 1 and Claim 2 wherein the eccentric motion of a groove is transmitted to four levers which oscillate four shafts to drive four freewheel clutches.

4 A mechanical variable ratio drive system as claimed in Claim 1, Claim 2 and Claim 3 wherein the four freewheel clutch outputs are combined in four spur gears to give substantially constant angular velocity to these spur gears.

5 A mechanical variable ratio drive system as claimed in Claim 1, Claim 2, Claim 3 and Claim 4 where the four spur gears each transmit to each other torque sufficient to ensure that the output velocity of each gear is substantially free from discontinuities.

6 A mechanical variable ratio drive substantially as described herein with reference to Figures 1 to 4 of the accompanying drawing.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

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(ii) Int Cl (Edition 5) F16H 29/16, 29/18

Search Examiner
J A L CALVERT

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
8 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1 TO 6

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1354669 A (BRADBURY) see eg Figure 3	1-4
X	GB 0890522 A (BRADBURY) see Figures 5 and 6	1,3,4
X	GB 0532667 A (COOTE ET AL) see Figures 1 & 2	1,3,4
X	GB 0412050 A (DURR) see eg Figures 6 and 7	1-4
X	GB 0246644 A (LAWRENCE) see eg Figure 4	1-4

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

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